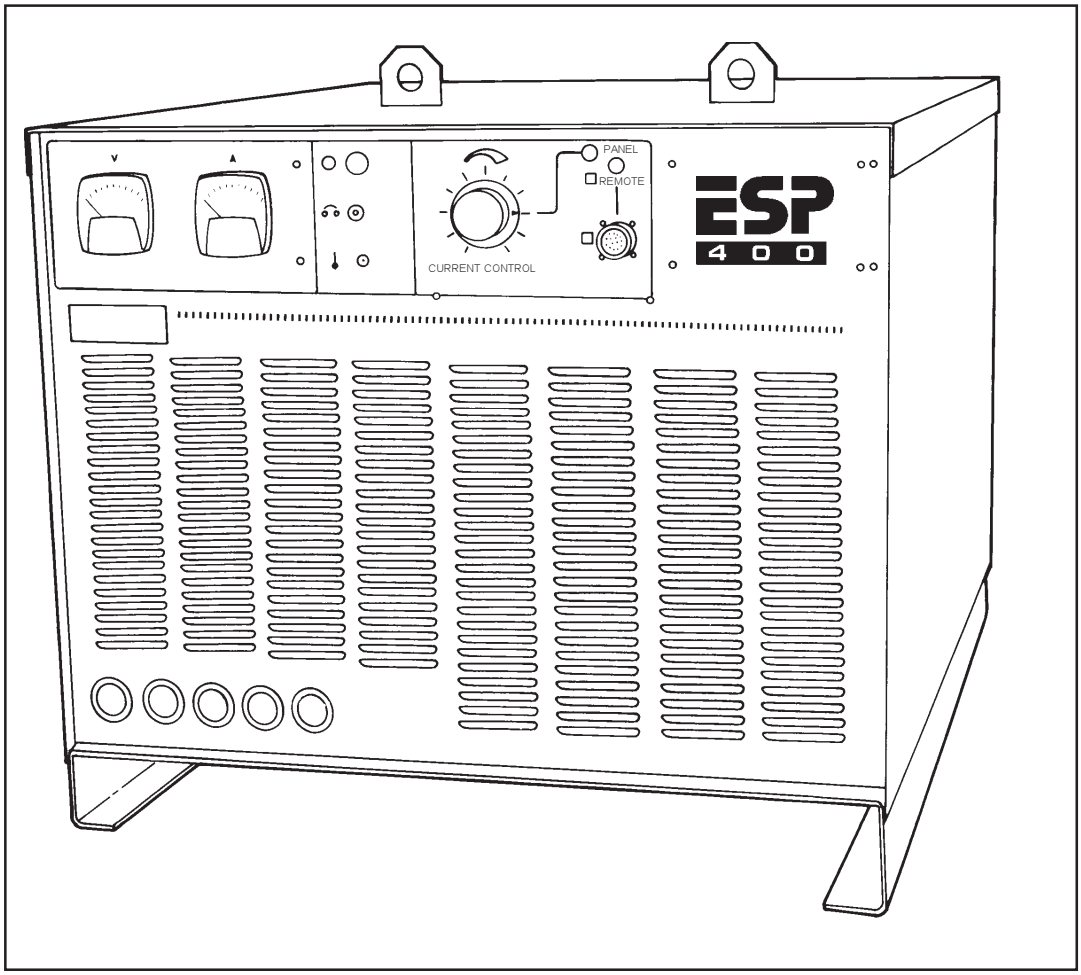
F-15-108-A
May, 1997

ESP-400
CUTTING POWER SOURCE

P/N 33518



MAINTENANCE MANUAL

CAUTION

These INSTRUCTIONS are for experienced operators. If you are not fully familiar with the principles of operation and safe practices for electric welding equipment, we urge you to read our booklet, "Precautions and Safe Practices for Arc Welding, Cutting, and Gouging", Form 52-529. Do NOT permit untrained persons to install, operate, or maintain this equipment. Do NOT attempt to install or operate this equipment until you have read and fully understand these instructions. If you do not fully understand these instructions, contact your supplier for further information. Be sure to read the Safety Precautions (Section I) before installing or operating this equipment.

Be sure this information reaches the operator.
You can get extra copies through your supplier.

ESAB Welding & Cutting Products

USER RESPONSIBILITY

This equipment will perform in conformity with the description thereof contained in this manual and accompanying labels and/or inserts when installed, operated, maintained and repaired in accordance with the instructions provided. This equipment must be checked periodically. Defective equipment should not be used. Parts that are broken, missing, worn, distorted or contaminated should be replaced immediately. Should such repair or replacement become necessary, the manufacturer recommends that a telephone or written request for service advice be made to the Authorized Distributor from whom purchased.

This equipment or any of its parts should not be altered without the prior written approval of the manufacturer. The user of this equipment shall have the sole responsibility for any malfunction which results from improper use, faulty maintenance, damage, improper repair or alteration by anyone other than the manufacturer or a service facility designated by the manufacturer.

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SAFETY PRECAUTIONS

WARNING: These Safety Precautions are for your protection. They summarize precautionary information from the references listed in Additional Safety Information section. Before performing any installation or operating procedures, be sure to read and follow the safety precautions listed below as well as all other manuals, material safety data sheets, labels, etc. Failure to observe Safety Precautions can result in injury or death.

PROTECT YOURSELF AND OTHERS -- Some welding, cutting, and gouging processes are noisy and require ear protection. The arc, like the sun, emits ultraviolet (UV) and other radiation and can injure skin and eyes. Hot metal can cause burns. Training in the proper use of the processes and equipment is essential to prevent accidents. Therefore:

1. Always wear safety glasses with side shields in any work area, even if welding helmets, face shields, and goggles are also required.
2. Use a face shield fitted with the correct filter and cover plates to protect your eyes, face, neck, and ears from sparks and rays of the arc when operating or observing operations. Warn bystanders not to watch the arc and not to expose themselves to the rays of the electric-arc or hot metal.
3. Wear flameproof gauntlet type gloves, heavy long-sleeve shirt, cuffless trousers, high-topped shoes, and a welding helmet or cap for hair protection, to protect against arc rays and hot sparks or hot metal. A flameproof apron may also be desirable as protection against radiated heat and sparks.
4. Hot sparks or metal can lodge in rolled up sleeves, trouser cuffs, or pockets. Sleeves and collars should be kept buttoned, and open pockets eliminated from the front of clothing
5. Protect other personnel from arc rays and hot sparks with a suitable non-flammable partition or curtains.
6. Use goggles over safety glasses when chipping slag or grinding. Chipped slag may be hot and can fly far. Bystanders should also wear goggles over safety glasses.

FIRES AND EXPLOSIONS -- Heat from flames and arcs can start fires. Hot slag or sparks can also cause fires and explosions. Therefore:

1. Remove all combustible materials well away from the work area or cover the materials with a protective non-flammable covering. Combustible materials include wood, cloth, sawdust, liquid and gas fuels, solvents, paints and coatings, paper, etc.
2. Hot sparks or hot metal can fall through cracks or crevices in floors or wall openings and cause a hidden smoldering fire or fires on the floor below. Make certain that such openings are protected from hot sparks and metal.“
3. Do not weld, cut or perform other hot work until the workpiece has been completely cleaned so that there are no substances on the workpiece which might produce flammable or toxic vapors. Do not do hot work on closed containers. They may explode.
4. Have fire extinguishing equipment handy for instant use, such as a garden hose, water pail, sand bucket, or portable fire extinguisher. Be sure you are trained in its use.
5. Do not use equipment beyond its ratings. For example, overloaded welding cable can overheat and create a fire hazard.
6. After completing operations, inspect the work area to make certain there are no hot sparks or hot metal which could cause a later fire. Use fire watchers when necessary.
7. For additional information, refer to NFPA Standard 51B, "Fire Prevention in Use of Cutting and Welding Processes", available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

ELECTRICAL SHOCK -- Contact with live electrical parts and ground can cause severe injury or death. DO NOT use AC welding current in damp areas, if movement is confined, or if there is danger of falling.

1. Be sure the power source frame (chassis) is connected to the ground system of the input power.
2. Connect the workpiece to a good electrical ground.
3. Connect the work cable to the workpiece. A poor or missing connection can expose you or others to a fatal shock.
4. Use well-maintained equipment. Replace worn or damaged cables.
5. Keep everything dry, including clothing, work area, cables, torch/electrode holder, and power source.
6. Make sure that all parts of your body are insulated from work and from ground.
7. Do not stand directly on metal or the earth while working in tight quarters or a damp area; stand on dry boards or an insulating platform and wear rubber-soled shoes.
8. Put on dry, hole-free gloves before turning on the power.
9. Turn off the power before removing your gloves.
10. Refer to ANSI/ASC Standard Z49.1 (listed on next page) for specific grounding recommendations. Do not mistake the work lead for a ground cable.

ELECTRIC AND MAGNETIC FIELDS — May be dangerous. Electric current flowing through any conductor causes localized Electric and Magnetic Fields (EMF). Welding and cutting current creates EMF around welding cables and welding machines. Therefore:

1. Welders having pacemakers should consult their physician before welding. EMF may interfere with some pacemakers.
2. Exposure to EMF may have other health effects which are unknown.
3. Welders should use the following procedures to minimize exposure to EMF:
   A. Route the electrode and work cables together. Secure them with tape when possible.
   B. Never coil the torch or work cable around your body.
   C. Do not place your body between the torch and work cables. Route cables on the same side of your body.
   D. Connect the work cable to the workpiece as close as possible to the area being welded.
   E. Keep welding power source and cables as far away from your body as possible.

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FUMES AND GASES -- Fumes and gases, can cause discomfort or harm, particularly in confined spaces. Do not breathe fumes and gases. Shielding gases can cause asphyxiation. Therefore:

1. Always provide adequate ventilation in the work area by natural or mechanical means. Do not weld, cut, or gouge on materials such as galvanized steel, stainless steel, copper, zinc, lead, beryllium, or cadmium unless positive mechanical ventilation is provided. Do not breathe fumes from these materials.
2. Do not operate near degreasing and spraying operations. The heat or arc rays can react with chlorinated hydrocarbon vapors to form phosgene, a highly toxic gas, and other irritant gases.
3. If you develop momentary eye, nose, or throat irritation while operating, this is an indication that ventilation is not adequate. Stop work and take necessary steps to improve ventilation in the work area. Do not continue to operate if physical discomfort persists.
4. Refer to ANSI/ASC Standard Z49.1 (see listing below) for specific ventilation recommendations.

CYLINDER HANDLING -- Cylinders, if mishandled, can rupture and violently release gas. Sudden rupture of cylinder, valve, or relief device can injure or kill. Therefore:

1. Use the proper gas for the process and use the proper pressure reducing regulator designed to operate from the compressed gas cylinder. Do not use adaptors. Maintain hoses and fittings in good condition. Follow manufacturer's operating instructions for mounting regulator to a compressed gas cylinder.
2. Always secure cylinders in an upright position by chain or strap to suitable hand trucks, undercarriages, benches, walls, post, or racks. Never secure cylinders to work tables or fixtures where they may become part of an electrical circuit.
3. When not in use, keep cylinder valves closed. Have valve protection cap in place if regulator is not connected. Secure and move cylinders by using suitable hand trucks. Avoid rough handling of cylinders.
4. Locate cylinders away from heat, sparks, and flames. Never strike an arc on a cylinder.
5. For additional information, refer to CGA Standard P-1, "Precautions for Safe Handling of Compressed Gases in Cylinders", which is available from Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA 22202.

EQUIPMENT MAINTENANCE -- Faulty or improperly maintained equipment can cause injury or death. Therefore:

1. Always have qualified personnel perform the installation, troubleshooting, and maintenance work. Do not perform any electrical work unless you are qualified to perform such work.
2. Before performing any maintenance work inside a power source, disconnect the power source from the incoming electrical power.
3. Maintain cables, grounding wire, connections, power cord, and power supply in safe working order. Do not operate any equipment in faulty condition.
4. Do not abuse any equipment or accessories. Keep equipment away from heat sources such as furnaces, wet conditions such as water puddles, oil or grease, corrosive atmospheres and inclement weather.
5. Keep all safety devices and cabinet covers in position and in good repair.
6. Use equipment only for its intended purpose. Do not modify it in any manner.

ADDITIONAL SAFETY INFORMATION -- For more information on safe practices for electric arc welding and cutting equipment, ask your supplier for a copy of "Precautions and Safe Practices for Arc Welding, Cutting and Gouging", Form 52-529.

The following publications, which are available from the American Welding Society, 550 N.W. LeJuene Road, Miami, FL 33126, are recommended to you:

1. ANSI/ASC Z49.1 - "Safety in Welding and Cutting"
2. AWS C5.1 - "Recommended Practices for Plasma Arc Welding"
3. AWS C5.2 - "Recommended Practices for Plasma Arc Cutting"
4. AWS C5.3 - "Recommended Practices for Air Carbon Arc Gouging and Cutting"
5. AWS C5.5 - "Recommended Practices for Gas Tungsten Arc Welding“
6. AWS C5.6 - "Recommended Practices for Gas Metal Arc Welding""
7. AWS SP - "Safe Practices" - Reprint, Welding Handbook.
8. ANSI/AWS F4.1, "Recommended Safe Practices for Welding and Cutting of Containers That Have Held Hazardous Substances."

This symbol appearing throughout this manual means **Attention! Be Alert! Your safety is involved.**

The following definitions apply to DANGER, WARNING, CAUTION found throughout this manual:

DANGER Used to call attention to immediate hazards which, if not avoided, will result in immediate, serious personal injury or loss of life.

WARNING Used to call attention to potential hazards which could result in personal injury or loss of life.

CAUTION Used to call attention to hazards which could result in minor personal injury.

2.1 Introduction

The ESP-400 Plasma Power Source is designed for high speed plasma cutting applications. It is normally used with equipment such as the ESAB Smart Plasma System (ESP). For cutting currents beyond the rating of the ESP-400, parallel operation of these units is permissible. It is also possible to operate in parallel (see ref on figure 5-2) with the ULTRA-LIFE 300 or ESP-600 cutting Power Source. For additional operating data and electrical characteristics of this machine, refer below to Table 2-1, ESP-400 Specifications.

TABLE 2-1. ESP-400 SPECIFICATIONS

Rated Output	100% Duty	400 A @ 200 V dc
	50% Duty*	500 A @ 200 V dc
Output Current Range		100 to 500 Amperes
Open Circuit Voltage		417 V dc
Input Voltage		460 V ac, 60 Hz, 3-phase 380 V ac, 50 Hz, 3-phase 415 V ac, 50 Hz, 3-phase
Input Current @ Rated Output	400 A Output	156 A @ 460 V ac, 60 Hz 173 A @ 415 V ac, 50 Hz 189 A @ 380 V ac, 50 Hz
	500 A Output	195 A @ 460 V ac, 60 Hz 216 A @ 415 V ac, 50 Hz 237 A @ 380 V ac, 50 Hz
Power Factor @ Rated Load		Approx. 75%
Dimensions	Width Depth Height	36.75 in. (933.5 mm) 43.50 in. (1105 mm) 31.00 in. (787.4 mm)
Weight		1830 lbs (830 kg)

*The 50% duty cycle is based on a 1-hour period; for example, 30 minutes "on" and 30 minutes "off" with fan running.

2.2 Description

The ESP-400 Plasma Power Source is a silicon controlled rectifier (SCR), three-phase transformer/rectifier type dc unit with solid state circuitry. The unit can be operated from 100 to 500 amperes at duty cycles shown in Table 2-1, above. A current control Panel-Remote Switch determines the location from which the output current will be regulated: either locally from the Power Source front panel (“Panel” position) or remotely ("Remote" position) from a precision 0-10 volt reference (V ref) signal.

The Power Source circuitry receiving the V ref signal is electrically (galvanically) isolated. This means that the common for this signal may be tied to any voltage less than 150 V ac or dc with respect to earth ground.

The ESP-400 is powered by a three-phase main transformer which combines with solid state control to provide volt-amperes curve output characteristics required for plasma cutting (see figure 2-1). A three-phase full wave SCR and diode bridge rectifier are used to convert the ac output current from the transformer to dc cutting current, and also control the output current through the SCRs. A network of integrally-mounted capacitors and resistors provide transient and high frequency voltage protection to the rectifier SCRs and diodes. Protection for the main transformer bridge rectifier and the inductor is provided by over-temperature thermal switches which interrupt power in the event of an overheating condition and automatically reset when the components have cooled to their normal operating temperature. Filtering of the dc output current is provided by an inductor.

The solid state circuitry of the ESP-400 produces stable cutting current and eliminates changes in output current as components heat up and/or if input line voltage changes within ±10% of nominal. In addition, the control circuit has built-in line voltage compensation, which corrects the output of the Power Source for various changes in the input line voltage. This feature ensures consistency in cutting conditions even if line voltage changes. Actual load current and voltage are indicated by an ammeter and voltmeter mounted on the front panel.

Connections for control functions from the Flow Control assembly are made from a 19-pin plug receptacle on the front panel. This receptacle provides connection for auxiliary 115 volts out, remote current control.

The Power Source is designed for ease in moving and handling. Sufficient clearance and reinforcement at its base permits lifting with a fork lift truck; or raising with a crane or hoist using the lifting rings in the top cover.

⚠ CAUTION

When moving the power source, always use both lifting rings in order to keep the power source level, otherwise serious internal damage may occur.

2.3 Cool-Down Periods

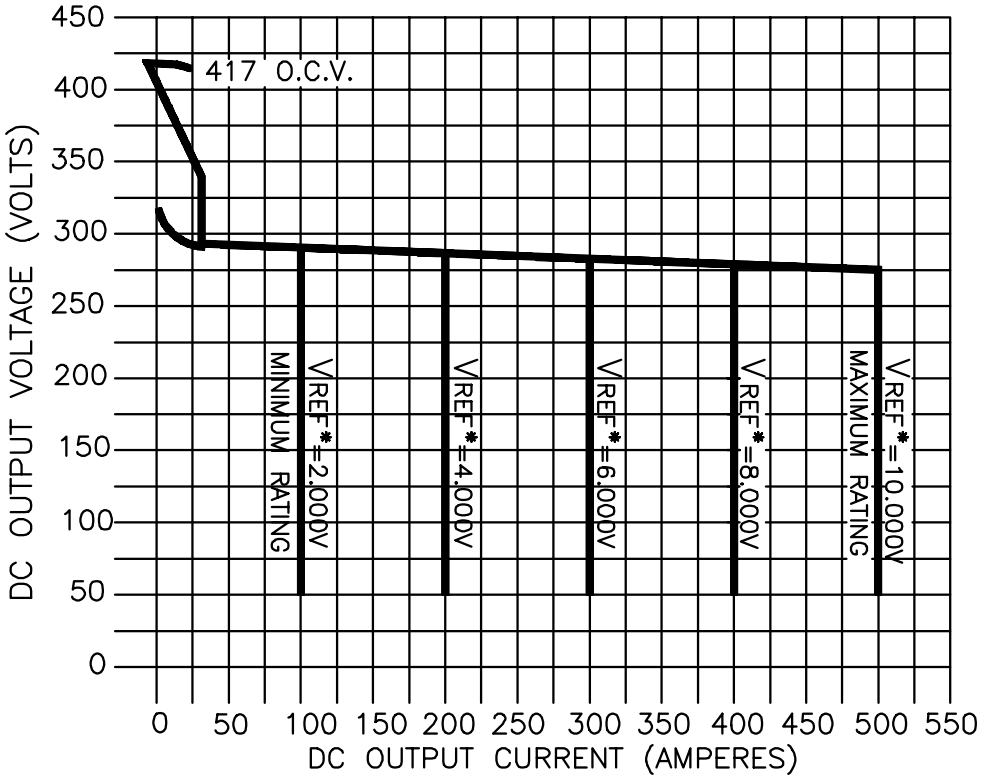
The ESP-400 Power Source has two cool-down periods: 1) 100% duty @ 400 amperes (400 amperes may be applied continuously without a cool-down period); 2) 50% duty - 1 hour base period @ 500 amperes (500 amperes may be applied continuously for 30 minutes followed by a 30 minute cool-down period with fan motor running. This cool-down period is proportionately less for shorter operating periods).

⚠ CAUTION

Output ratings are designed and based on an unobstructed supply of cooling air flow over its internal components. DO NOT USE FILTERS ON THIS UNIT. Periodically blow out dirt accumulations, using low pressure air.

2.4 Volt-Ampere Curves

The volt-ampere curves show the output voltage available at any given output current for the various current control (or V ref signals from CNC control) settings. Values for settings other than those shown in figure 2-1, fall between the Minimum and Maximum curves shown.



• THE V_{REF} DESIGNATION SHOWN ON THE TYPICAL V/A CURVES (ABOVE) CORRESPONDS TO AN ABSOLUTE VOLTAGE REFERENCE SIGNAL (0 TO 10 VOLT RANGE) FROM THE CNC (CUTTING) CONTROL THAT ESTABLISHES THE PRECISE OUTPUT ARC CURRENT OF THE POWER SOURCE. THESE CURVES ARE DERIVED FROM THE FORMULA $I_{ARC} = 50\ V_{REF}$

Figure 2-1. Volt-Ampere Curves

2.5 Power Source Connections

A. For operation of two ESP-400 Power Sources in parallel, there is one master power source and one slave power source. The master power source utilizes the standard transformer configuration, and the slave power source utilizes an alternate configuration for 180° phase shift (see Figure 2-2).

The master power source is the one utilizing the 19-conductor cable from the front of the flow control and is also the one to which the pilot arc wire is connected. The slave power source utilizes the 19-conductor cable, P/N 33940, connected to the designated receptacle at the back of the flow control.

In addition to reconnecting the main transformer and considerations of connecting the flow control and pilot arc wire, the slave unit is different from the master unit in the following ways:

1. The boost bridge fuses must be removed from the slave power source. The boost bridge is located on the base under the main bridge. Access to the fuses is made from the left side with the left side panel removed. (Left side is viewed while standing in front of the power source looking at the meters.)

2. The black wire connecting the negative of C21 to the positive of C22 must be removed from the positive of C22 in the slave power source. The wire should be looped by attaching both ends to the negative of C21. This will eliminate the concern of the loose end shorting to other conductors. (C21 and C22 are the two large capacitors located on the base near the input power strain relief. (See Figure 5-2.)

B. For single Power source operation, either the master or the slave unit may be used, provided items 1. through 5. below are addressed. It is not necessary to reconnect the main transformer in the slave unit. Both the standard and alternate configurations work equally well for single power source operation. Implementation of items 4. and 5. below effectively convert the slave power source into a master power source.

1. Disconnect the negative output cable from the power source not being used. To prevent the removed cable from being electrically “hot” when the other power source is activated, remove the opposite end of the cable from the plumbing box and insulate both ends with electrical tape.

2. If the slave power source is used, disconnect the 19-conductor cable from the front of the power source and plug in the cable from the front of the flow control.

3. If the slave power source is used, move the pilot arc wire from the master unit to the slave unit.

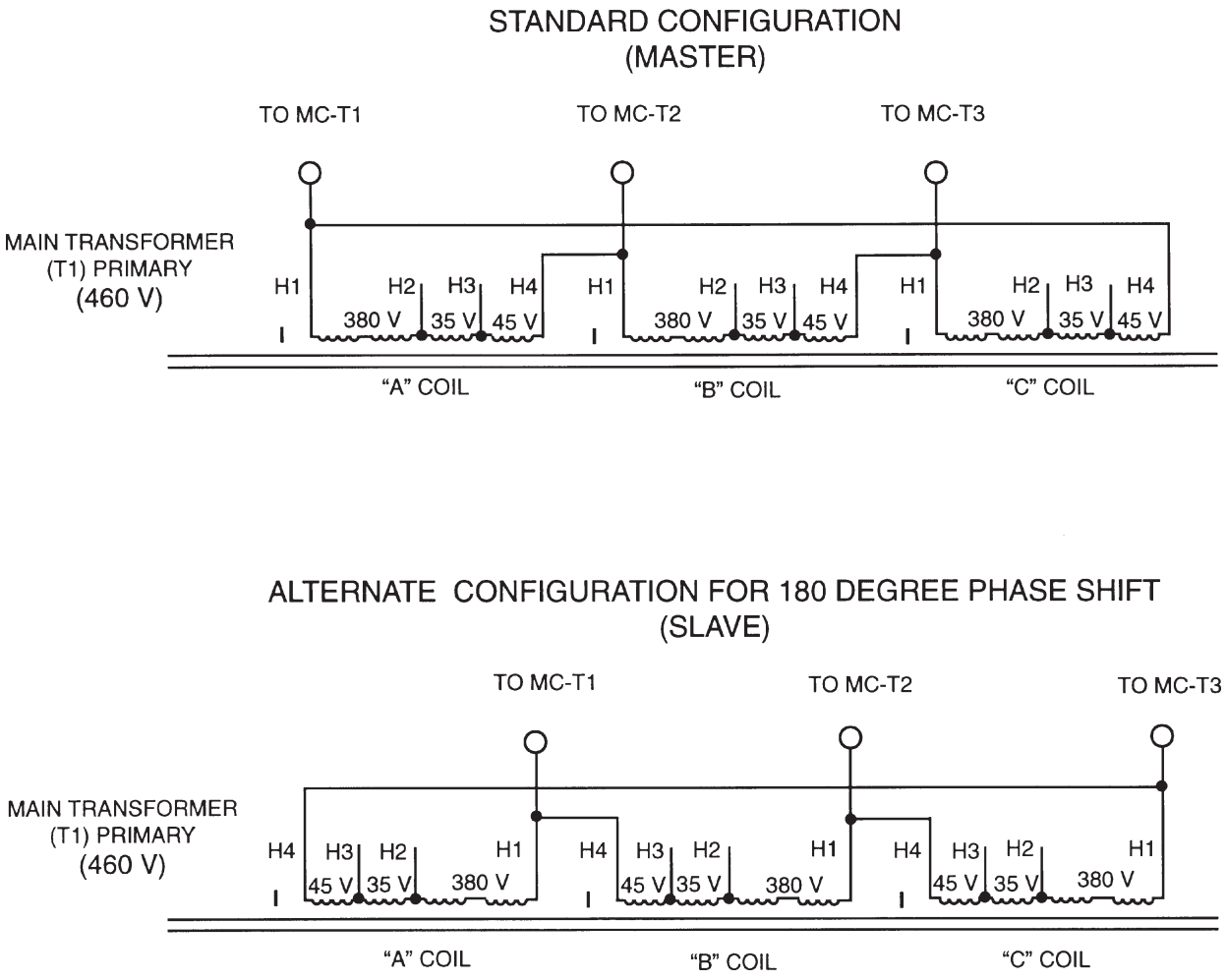
4. If the slave power source is used, install the boost supply fuses.

5. If the slave power source is used, using the black wire on the negative C21, connect the negative of C21 to the positive of C22.

C. Both master and slave power sources may be reconnected to the alternate main transformer configuration from the standard configuration. Likewise, both master and slave power sources may be reconnected to the standard configuration from the alternate configuration. The following instructions are for changing both to and from the standard and alternate configurations.

1. Identify the three wires from the main contactor connected to the H1 taps of the main transformer. These wires will not be moved during reconnection.

2. In addition to the contactor wires, each transformer primary has two other wires connected to each coil. Find these wires and reverse them, taking care to work with only one coil at a time. Working with more than one coil at a time can result in mixing up wires from different coils. Refer to the schematics depicting the standard and alternate main transformer configurations (Figure 2-2).



TO CHANGE TO 380 V OR 415 V INPUT:

On the main transformer (T1) - both master and slave:

For 415 V input, move the wire from H4 to H3 for all three coils.
For 380 V input, move the wire from H4 to H2 for all three coils.

On the control transformer (T2):

For 415 V input, move the brown wire on H9 to H6.
For 380 V input, move the brown wire on H9 to H5.

Figure 2-2. Master and Slave Configurations

3.1 General

If this equipment does not operate properly, stop work immediately and investigate the cause of the malfunction. Maintenance work must be performed by an experienced person, and electrical work by a trained electrician. Do not permit untrained persons to inspect, clean, or repair this equipment. Use only recommended replacement parts.

⚠ WARNING

TO PREVENT ACCIDENTAL ELECTRIC SHOCK, BE SURE THAT THE WALL DISCONNECT SWITCH OR CIRCUIT BREAKER IS OPEN BEFORE ATTEMPTING ANY INSPECTION OR WORK INSIDE THE POWER SOURCE.

3.2 Cleaning

Since there are no moving parts (other than the fan) in the power source, maintenance consists mainly of keeping the interior of the cabinet clean. Periodically, remove the cover from the cabinet and blow accumulated dust and dirt from the air passages and the interior components, using clean, dry low pressure air. It is imperative that the air passages to the interior of the unit be kept free of dirt accumulation to ensure adequate circulation of cooling air, especially over the extrusion fins of bridge rectifier. This unit is NOT designed to be used with air filters of any kind. Any obstruction to the free flow of cooling air may damage the machine and void the warranty. The frequency of cleaning needed depends upon the amount of dirt that is drawn into the unit.

3.3 Lubrication

Fan motors with oil tubes located on the side of the motor require lubrication after one year of service. Motors without oil tubes are permanently lubricated and should not require any attention.

3.4 Testing and Replacing Bridge Assembly Components

The silicon diodes and SCRs used in the Power Source are devices which allow current to flow in only one direction. They block current flow in the other direction. The diodes and SCRs used in this Power Source are designed to provide long trouble-free operation; however, should a failure occur, they require replacement. The location and replacement parts data for the diodes and SCRs are shown in figures 5-1 through 5-4.

If after troubleshooting, the "trouble symptom" appears to be in the Bridge or Boost Bridge (BR, BBR) networks: the following three-part procedure can be used to determine the faulty component(s): Visual Analysis, Component Group Testing, and Individual Component/Isolation Testing.

If component repair or replacement is necessary, the Boost Bridge components are readily accessible in the power source; however, to service Main Bridge components, removing the bridge assembly is recommended.

⚠ CAUTION

Before removing the main bridge assembly for servicing, carefully tag (identify) all interconnecting wires and bus connections to facilitate proper reinstallation. Also, refer to the diagrams and illustrations in the back of this book.

A. Visual Analysis For Defective BR/BBR Components.

1. Remove top and left side panels of Power Source. Inspect the 500 A BR fuse links (F3 and F4) mounted in the Main Transformer secondary bus bars to see if they have blown. If not blown, check the 30 A BBR cartridge fuses (F1 and F2) with an ohmmeter to determine if they are open.

2. If either or both of the fuses protecting its respective bridge assembly are open, it's a sign that one or more of the diodes or SCRs in that particular bridge may be shorted.

3. Refer to figure 3-1 for the makeup of a fuse and information to prevent hardware from loosening due to thermal cycling.

NOTE

Figure 3-1 depicts one end of one fuse. The other end is the same.

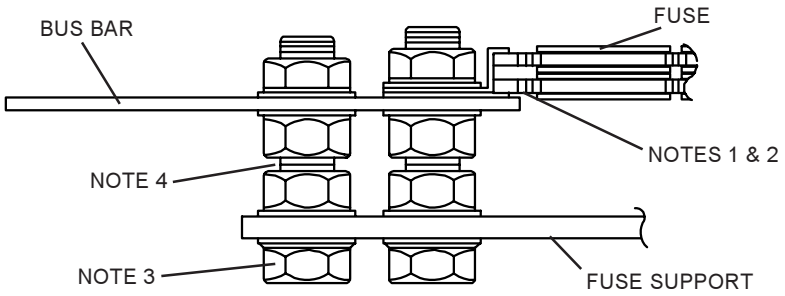


Figure 3-1. Fuse Assembly

NOTES:

1. Fuse link must be in direct contact with copper bus bar (no hardware in between). Apply electrical joint compound between fuse link and bus bar.
2. Wire brush bus bar and fuse link at mating point prior to installing to prevent overheating and to ensure good electrical contact.
3. Any 1/4-inch bolt or screw is usable if threaded completely to head or within 1/4 inch of head. A 1/4-inch threaded rod may be substituted for bolt or screw.
4. It is critical that a space (one full turn) remain between nuts.

4. Check for cracked or broken ceramic around each diode pigtail of SCR body. If cracked, it's a sign of a shorted diode or SCR. When the larger diodes or SCRs fail, they most commonly fail shorted.

B. Testing Main Bridge Rectifier (MBR) Assembly.

The Main Bridge essentially contains three groups of components to be tested: Power Diodes D4, D5, and D6; Freewheeling Diode D7; and SCRs 4, 5, and 6. The group testing sequence does not require electrical isolation; however, to determine the specific faulty component in a group, some form of isolation may be required as follows:

1. Checking Power Diode Group D4, D5 and D6.

(a) If fuse links F3 and F4 are not blown, use an ohmmeter set at its lowest resistance scale and check the diode group as described in step 1.(c). Checking any one diode within the group will determine if the group is good or if a shorted condition exists. If there is a short, you must electrically isolate to

determine the specific component. Electrical isolation is accomplished by unbolting the pigtail of the diode being tested.

(b) If one or more fuse links (F3/F4) are blown, the diodes must be isolated and checked individually.

(c) Ohmmeter check of diodes (group or individual).

NOTE

Some analog meters and most digital meters will read similarly high both before and after reversing the meter leads when testing good diodes and SCRs.

1 Place one test probe on NEG heatsink (diode stud) and the other probe to each diode pigtail's SCR heatsink. Note the resistance readings obtained. All three readings should be similar (high or low).

2 Reverse the test probes and recheck the diodes. Note each resistance reading. All three readings should be similar; but, opposite of those noted in the first reading.

3 Diodes are good if they test high in one direction and low in the opposite direction. Diodes are bad if the resistance readings are low in both directions. High readings in both directions when using a digital ohmmeter indicates a good diode.

4 Diodes are bad when they show no, or very low, resistance in both directions indicating they are shorted. Although it is possible for power rectifier diodes to fail "open", such failures are rare, particularly for the larger diodes. In the vast majority of cases, a high resistance reading in either or both directions indicate a good diode.

2. Checking Freewheeling Diode D7.

This diode must be checked in the circuit using the same procedures outlined in steps 1.(a), 1.(b), and 1.(c). If the diode tests "good", nothing else need be done; however, if the diode tests "bad", you must disconnect its pigtail and retest it for verification.

3. Checking SCR Group SCR 4, 5 and 6.

NOTE

Before proceeding with the following SCR tests, all diodes D4, 5, 6 and 7 should have been checked, and defective (shorted) diodes electrically isolated.

(a) If fuse links F3 and F4 are not blown and are still connected to the bridge heatsink, use an ohmmeter set to its lowest resistance scale and check the SCR group as described in step 3.(c). Checking any one SCR within the group will determine if the group is good or if a shorted condition exists. If there is a short, you must electrically isolate to determine the specific faulty component, see step 3.(d).

(b) If one or more fuse links (F3/F4) are blown, the SCRs must be isolated and checked individually. Refer to step 3.(d).

(c) Ohmmeter check of SCRs (group or individual).

1. Place one test probe on the POS heatsink (same as the shunt) and touch the other test probe to each of the SCR's anode heatsinks. The resistance reading across each SCR should be 1000 (1K) ohms or higher.

2. Reverse the test probes and repeat the check. Again, the resistance reading across each SCR should be 1000 (1K) ohms or higher.

3. SCRs are bad if they show no or very low resistance reading in either direction.

(d) If the diagnosis indicates a defective SCR within the group, you must disconnect fuses F3 and F4 to electrically isolate the SCRs (assuming all diodes D4, 5, 6, 7 have checked good, or defective diodes previously isolated), and repeat the ohmmeter tests in steps 1, 2, and 3 above for each SCR.

C. Testing Boost Bridge Rectifier (BBR) Assembly.

1. Remove the 30 ampere fuses, F1 and F2, to electrically isolate the diodes of the BBR assembly from each other and the SCRs of the BBR assembly from each other. (It's always good practice to check the fuses for continuity to make sure whether they are good or bad. Use ohmmeter set to RX1 scale.)

2. Check diodes (D1, 2 and 3) with an ohmmeter set to the RX1 scale, as follows:

NOTE

Some analog meters and most digital meters will read similarly high both before and after reversing the meter leads when testing good diodes and SCRs.

(a) Place one test probe on the NEG heatsink (diode stud) and the other probe to each diode pigtail's SCR heatsink. Note the resistance reading obtained. All three readings should be similar (high or low).

(b) Reverse the test probes and recheck the diodes. Note each resistance reading. All three readings should be similar; but, opposite of those noted in the first reading.

(c) Diodes are good if they test high in one direction and low in the opposite direction. Diodes are bad if the resistance readings are low in both directions. High readings in both directions when using a digital ohmmeter indicates a good diode.

(d) Diodes are bad when they show no, or very low, resistance in both directions indicating they are shorted. Although it is possible for power rectifier diodes to fail "open", such failures are rare, particularly for the larger diodes. In the vast majority of cases, a high resistance reading in either or both directions indicate a good diode.

3. Check the SCRs (SCR1, 2 and 3) with an ohmmeter set to RX1 or RX100 scale, as follows:

(a) Place one test probe on the POS heatsink (SCR pigtails) and the other probe to each SCR's stud heatsink. All three readings should show a high resistance of 1000 (1K) ohms or higher.

(b) Reverse the test probes and recheck the SCRs. Again, all three readings should show a high resistance similar to the first test.

(c) An SCR is bad if it shows no, or very low resistance, in either direction.

D. Replacing Faulty SCRs and Diodes.

1. Make sure that heatsink mounting surfaces are cleaned before replacing faulty components.

2. For diodes and SCRs, coat mounting surfaces with Alcoa No. 2 EJC Electrical Joint Compound.

3. Clamping procedure for Main Bridge SCRs (4, 5 and 6).

(a) Tighten the SCR clamp nuts by hand until fingertight.

(b) Then, using a wrench, alternately tighten each nut 1/4 turn at a time until the “spring indicator” on the clamp assembly shows 1000-1500 pounds, or 1 to midway between 1 and 2 on the indicator.

4. Torque procedure for remaining SCRs and diodes.

Use a torque wrench to tighten stud mounted SCRs and diodes. Recommended torques are listed in table 3-1.

Table 3-1. Recommended Torques

Main Bridge Diodes D4, 5, 6, 7	Min., 275 in-lbs (23 ft · lbs) · Max., 325 in-lbs (27 ft · lbs) ·
Boost Bridge Diodes D1, 2, 3	Min., 20 in-lbs (1.7 ft · lbs) · Max., 30 in-lbs (2.5 ft · lbs) ·
Boost Bridge SCR's SCR1, 2, 3	Min., 125 in-lbs (10.4 ft · lbs) · Max., 150 in-lbs (12.5 ft · lbs) ·

4.1 General

WARNING

DISCONNECT PRIMARY POWER AT WALL SWITCH, OR CIRCUIT BREAKER, BEFORE ATTEMPTING INSPECTION OR WORK INSIDE OF THE POWER SOURCE.

If the Power Source is operating improperly, the following troubleshooting information may be used to locate the source of the trouble.

Check the problem against the symptoms in the following troubleshooting guide. The remedy for the problem may be quite simple. If the cause cannot be quickly located, open up the unit and perform a simple visual inspection of all the components and wiring. Check for proper terminal connections, loose or burned wiring or components, blown fuses, bulged or leaking capacitors, or any other sign of damage or discoloration.

4.2 Troubleshooting Guide

A. Fan Not Running.

1. No input power. Check main line (customer's) switch fuses.
2. Defective control transformer. Check for continuity.
3. Fan motor defective. Check motor and leads, and replace if necessary.

B. No Output.

1. No incoming three-phase power. Wall disconnect switch may be open, or fuse(s) blown.
2. Poor connections at output terminals. Tighten or replace connections.
3. Main contactor not energized:
   a. Thermal overload (TS1, 2, 3, 4, or 5) device(s) tripped.
   b. Contactor coil defective.
   c. Missing "start" signal.

C. Low Open Circuit Voltage (O.C.V.).

Normal O.C.V. is 417 volts for a nominal 460 volt line input. If your actual line voltage is running lower, your O.C.V. will be proportionately lower; if it's running higher, the O.C.V. will be proportionately higher. Regardless of the range, so long as O.C.V. is available it means that the main contactor (K1) is energized. However, if the voltage is approximately 300, it's a sign that you're only receiving your open circuit voltage from the Main Bridge Rectifier. This indicates that the Boost Bridge Rectifier is not supplying 417 volts.

1. Boost Bridge fuses F1 and/or F2 blown. (Fuse replacement specifications are critical -- only use 30 ampere, 250 volt, slo-blo or time-delay fuses; such as, Buss No. FNW30, Shawmut No. TRM30, or Factory replacements.)

2. Faulty SCRs or diodes in Boost Bridge assembly. Check per Section 3, paragraph 3.4, steps A and C.

3. SCR logic board defective. Replace board.

D. No Current Control or Erratic Output Current (O.C.V. is okay).

1. No current control -- none at all, fixed, or all out.

   a. Missing power or blown fuse links in Main or Boost Bridges.

   b. Defective SCR board.

   c. Defective constant current (CC) board.

   d. If current remains fixed at around 500 amperes (in Panel position), the bottom of the current control potentiometer (R28) may not be connected. This results in applying +10 volts straight into CC board.

   e. Missing V ref signal from remote source. Check voltage from pins P1-2 to P1-1 on CC board for V ref signal.

2. Erratic current control.

   a. Defective current control potentiometer (R28) (panel and/or remote location).

   b. Defective remote control switch (SW1). Check continuity.

E. Limited Output Current.

1. Single phasing resulting from blown fused link(s) F3 and/or F4, and/or defective SCR(s) or diodes in Main Bridge. Check per Section 3, paragraph 3.4 steps A, B, or D.

2. Defective SCR board, that is not gating one of the Main Bridge SCRs.

3. Insufficient V ref signal (less than 2.000 V).

F. Short (Torch) Tip Life -- Double Arcing.

1. Low open circuit voltage. Refer to symptom C.

2. Defective SCR board.

3. Defective CC board.

4. Defective SCR in Main Bridge.

5. Pilot Arc Work connection not properly made. Refer to ESP manual.

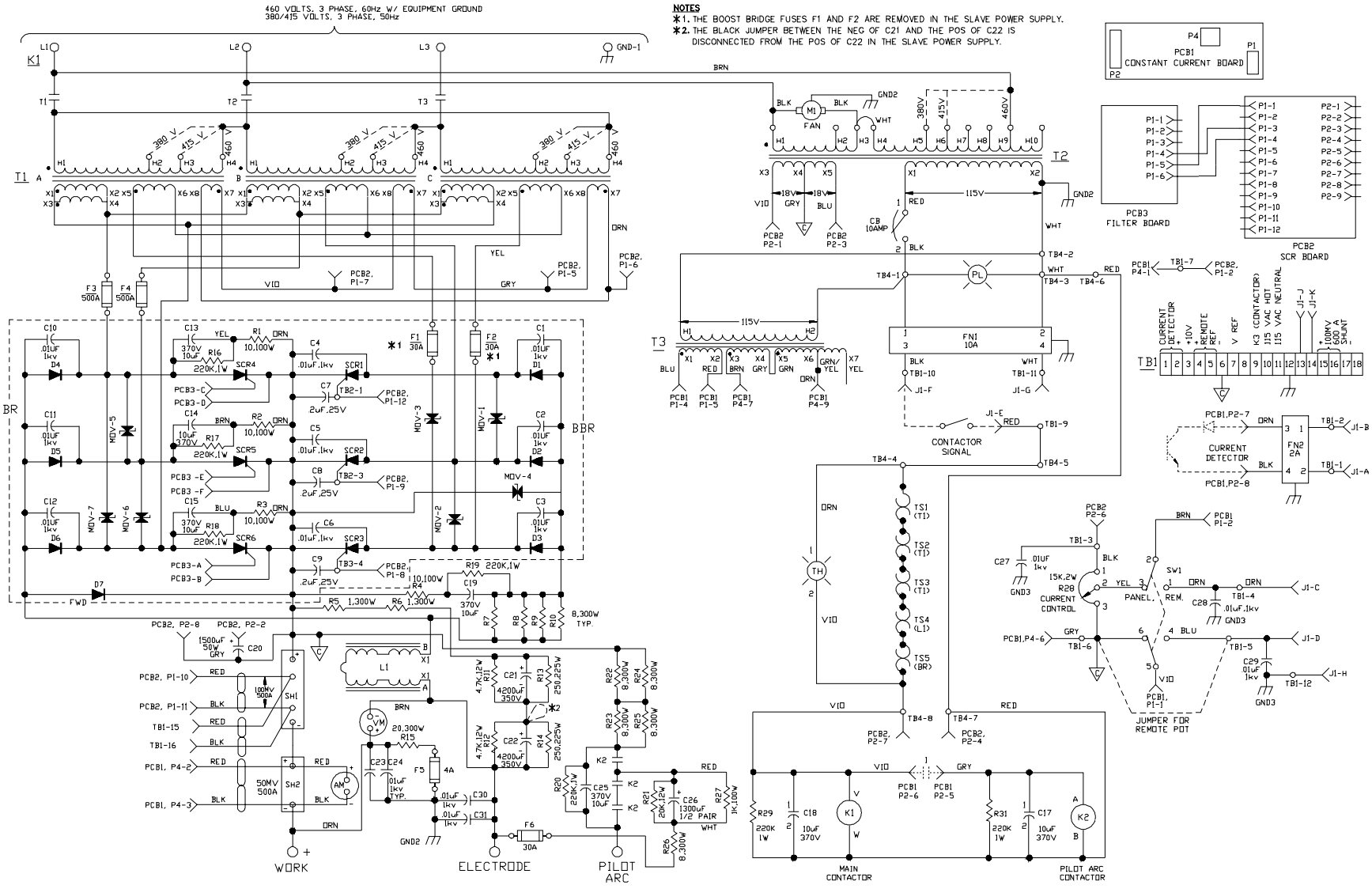
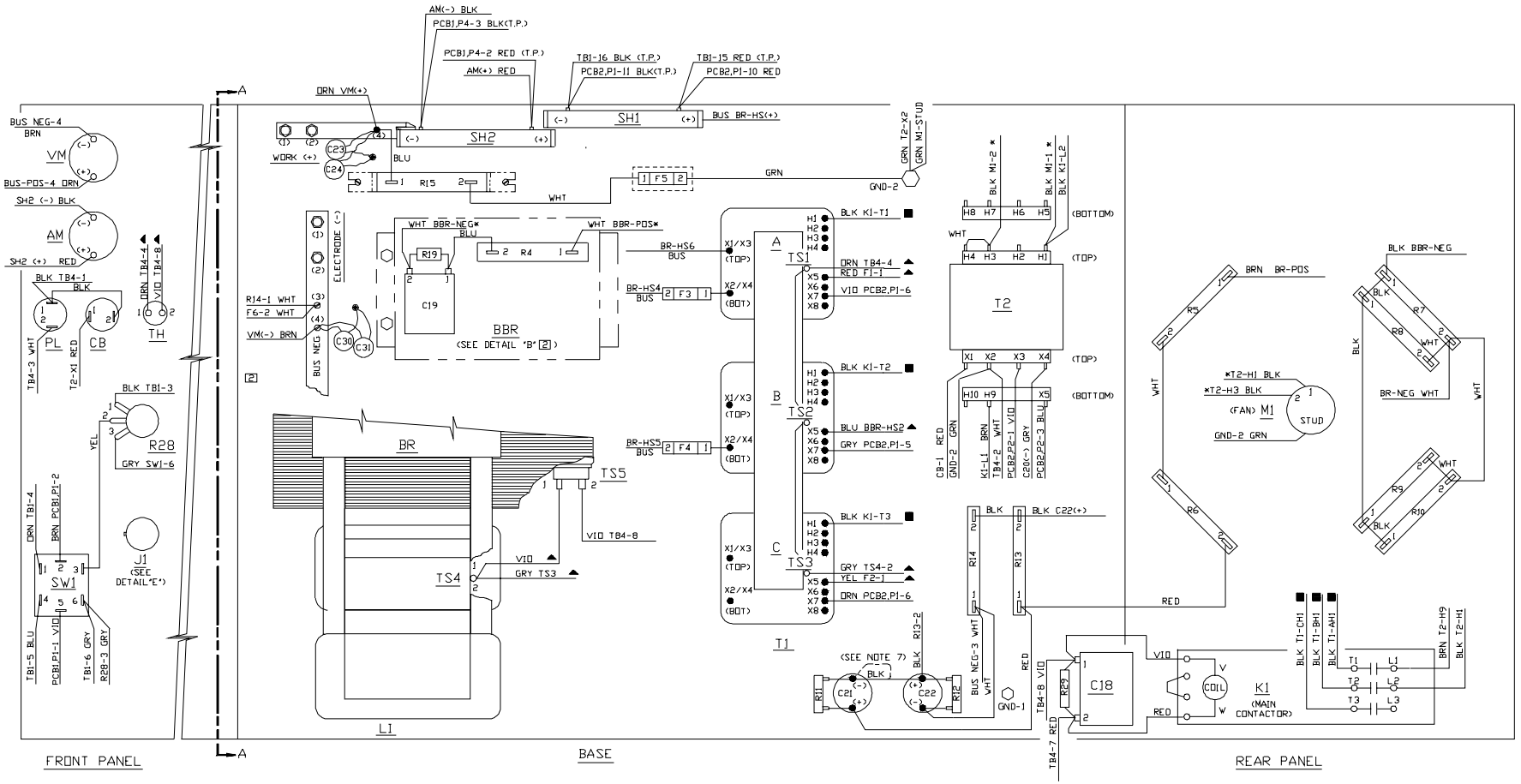

460 VOLTS, 3 PHASE, 60Hz W/ EQUIPMENT GROUND
380/415 VOLTS, 3 PHASE, 50Hz
NOTES
*1. THE BOOST BRIDGE FUSES F1 AND F2 ARE REMOVED IN THE SLAVE POWER SUPPLY.
*2. THE BLACK JUMPER BETWEEN THE NEG OF C21 AND THE POS OF C22 IS DISCONNECTED FROM THE POS OF C22 IN THE SLAVE POWER SUPPLY.
PCB1 CONSTANT CURRENT BOARD
PCB3 FILTER BOARD
PCB2 SCR BOARD
CONTACTOR SIGNAL
CURRENT DETECTOR
JUMPER FOR REMOTE POT
MAIN CONTACTOR
PILOT ARC CONTACTOR
WORK
ELECTRODE
PILOT ARC

Figure 4-1. ESP-400 Power Source Schematic Diagram



PCB2
DETAIL "C"

PCB2	P1-1	ORN	PCB3,P1-5
	P1-2	YEL	TB1-7
	P1-3	BLU	PCB3,P1-4
	P1-4	BRN	PCB3,P1-6
	P1-5	GRY	T1-BX7
	P1-6	ORN	T1-CX7
	P1-7	VIO	T1-AX7
	P1-8	GRY	TB3-4
	P1-9	VIO	TB2-3
	P1-10	RED	SH1(+)(T.P.)
	P1-11	BLK	SH1(-)(T.P.)
	P1-12	WHT	TB2-1

PCB2
DETAIL "D"

PCB2	P2-1	VIO	T2-X3
	P2-2	YEL	C20(+)
	P2-3	BLU	T2-X5
	P2-4	RED	TB4-7
	P2-5		
	P2-6	BLK	TB1-3
	P2-7	VIO	TB4-8
	P2-8	GRY	C20(-)
	P2-9		

DETAIL "E"

J1-A	BRN	TB1-1
J1-B	YEL	TB1-2
J1-C	ORN	TB1-4
J1-D	BLU	TB1-5
J1-E	RED	TB1-9
J1-F	BLK	TB1-10
J1-G	WHT	TB1-11
J1-H	GRN	TB1-12
J1-J	GRY	TB1-13
J1-K	VIO	TB1-14

J1
WIRING VIEW

NOTES:
1 * INDICATES SELF LEADS.
2 ● INDICATES 600V WIRE
3 ▮ INDICATES LEAD AND/OR CABLE ASS'Y.
4 ▲ INDICATES CONNECTION USING IN-LINE QUICK DISCONNECT.
5 □ REF. SHEET NUMBER.
6 "T.P." INDICATES TWISTED PAIRS
7 BLACK JUMPER BETWEEN NEG. OF C21 AND POS. OF C22 IS DISCONNECTED FROM THE POS. OF C22 IN THE SLAVE POWER SUPPLY

Figure 4-2. ESP-400 Power Source Wiring Diagram (Sheet 1 of 2)

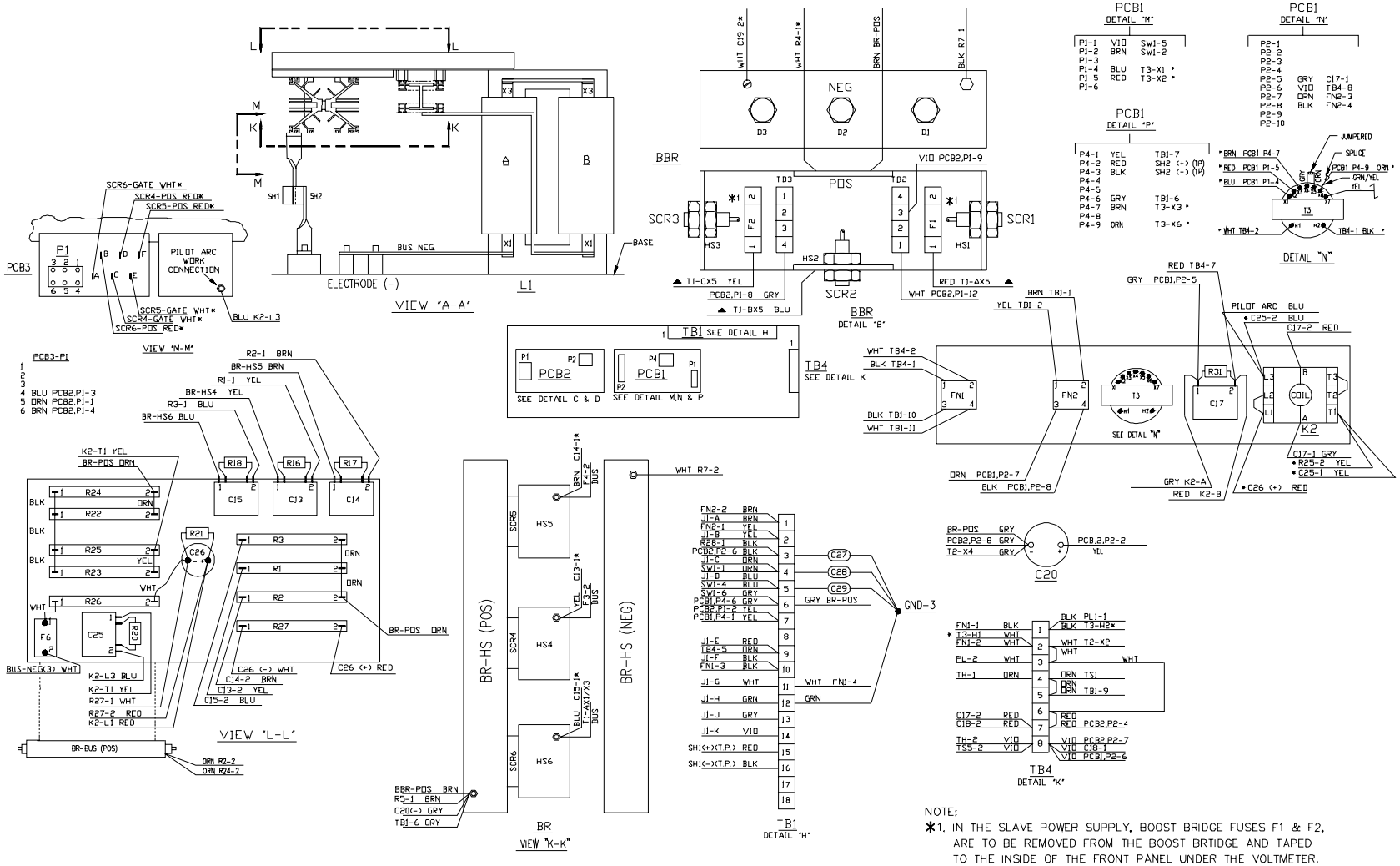


Figure 4-2. ESP-400 Power Source Wiring Diagram (Sheet 2 of 2)

SECTION 5 REPLACEMENT PARTS

5.1 General

Replacement Parts are illustrated on the following figures. When ordering replacement parts, order by part number and part name, as illustrated on the figure. DO NOT ORDER BY PART NUMBER ALONE.

Always provide the series or serial number of the unit on which the parts will be used. The serial number is stamped on the unit nameplate.

Replacement parts may be ordered from your ESAB distributor or from:

ESAB Welding and Cutting Products
Attn: Customer Service Dept.
P.O. Box 100545
411 S. Ebenezer Road
Florence, SC 29501-0545

Be sure to indicate any special shipping instructions when ordering replacement parts.

For technical assistance directly from an ESAB service representative, call (803) 664-4416. Additionally, ESAB offers toll free facsimile (FAX) service via 1-800-446-5693.

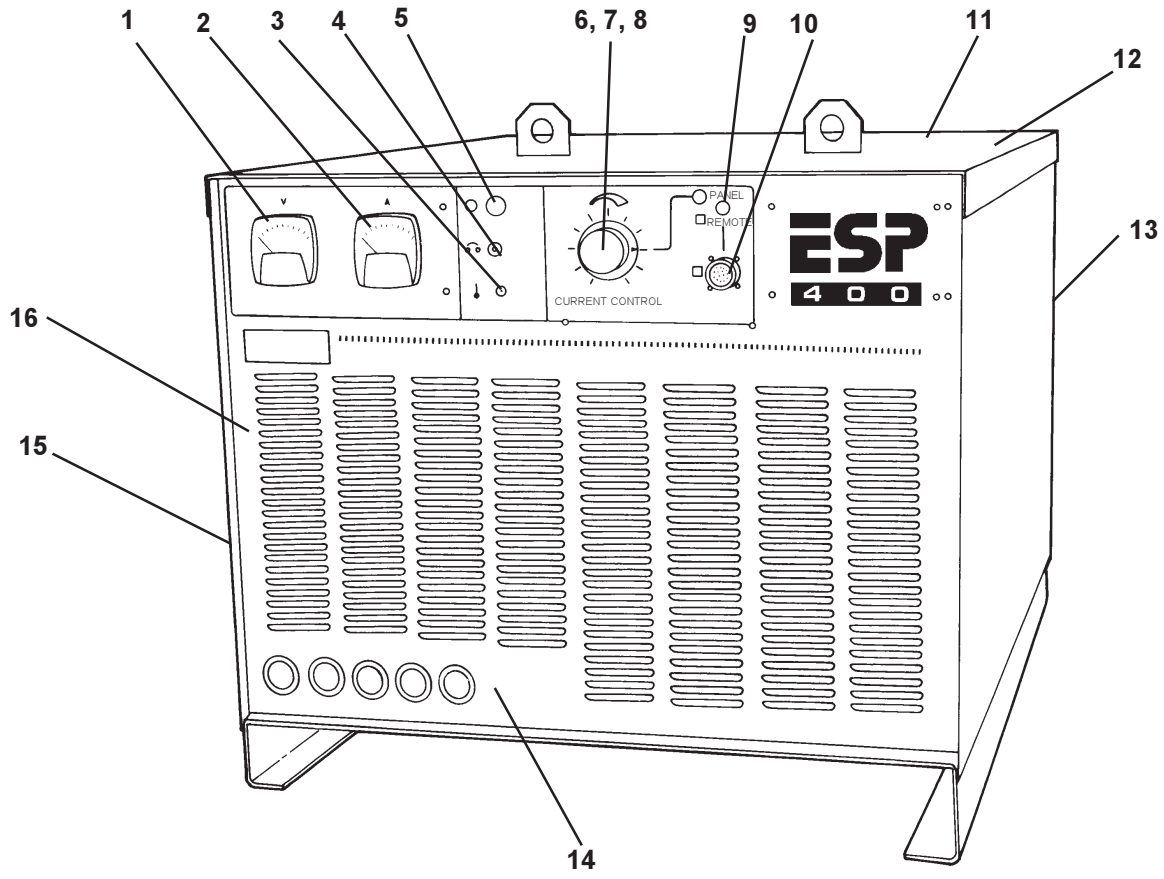


Figure 5-1. ESP-400 Power Source (Front View)

Item No.	Qty Req.	Part No.	Description	Ckt. Symbol
1	1	2062290	DC Voltmeter, 0-500 Volts	VM
2	1	672539	DC Ammeter, 0-500 Amperes	AM
3	1	598227	Miniature Pilot Light - Thermal Overload	TH
4	1	950122	10 Ampere Circuit Breaker	CB
5	1	672542	Pilot Light - Power	PL
6	1	9950715	*Current Control Potentiometer, 15K Ohms, 2 W	R28
7	1	673999	Shaft, Lock	
8	1	2062170	Knob	
9	1	634518	Panel - Remote Switch, DPDT	SW1
10	1	1006733	19-Pin Receptacle	J1
11	1	33077	Top Cover	
12	1	99513496	Decal, Warning (not shown)	
13	1	33076	Right Side Panel	
14	2	2091544	Decal, Warning (not shown)	
15	1	33075	Left Side Panel	
16	1	33073	Silk-screened Front Panel	

*Any linear potentiometer, 5K to 25K ohms, will work satisfactorily.

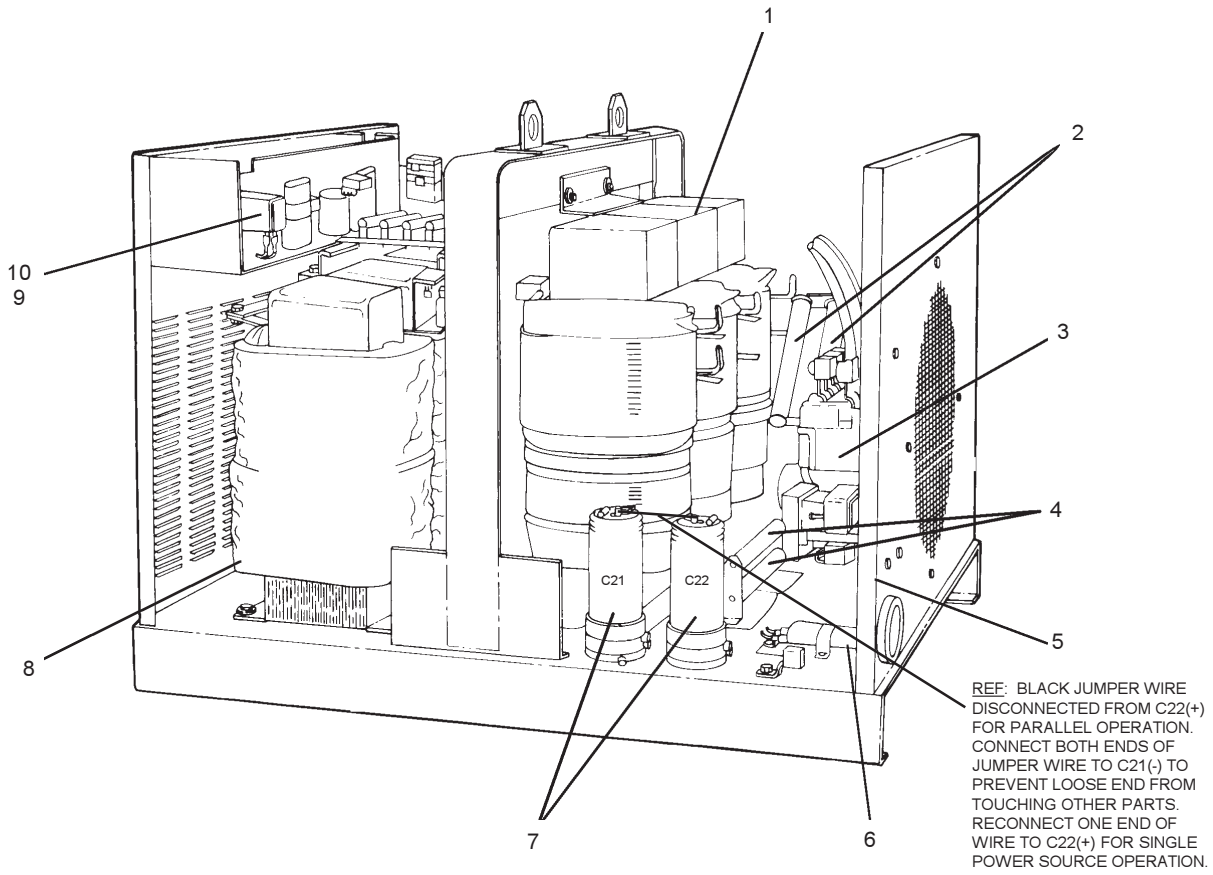


Figure 5-2. ESP-400 Power Source (Right Side View)

Item No.	Qty Req.	Part No.	Description	Circuit Symbol
1	1	33334	Main Transformer Assembly	T1
2	2	17300008	Resistor, 8 ohm, 300 W, 10% (fan shroud)	R9,10
3	1	950173	Main Contactor	K1
4	2	17295125	Resistor, 250 ohm, 225 W, 5% (on chassis base)	R13,14
5	1	33074	Rear Panel	
6	1	672772	Capacitor, 10 µF, 370 V ac (same as Item 2, figure 5-4)	C18
7	2	950627	Capacitor, 4200 µF, 350 W V dc	C21,22
8	1	33424	Inductor Assembly	L1
	1	2062211	Thermostat (P/O Item 8)	
9	1	951275	Filter, Line, 10 A	FN1
10	1	950116	Filter, Line, 2A	FN2

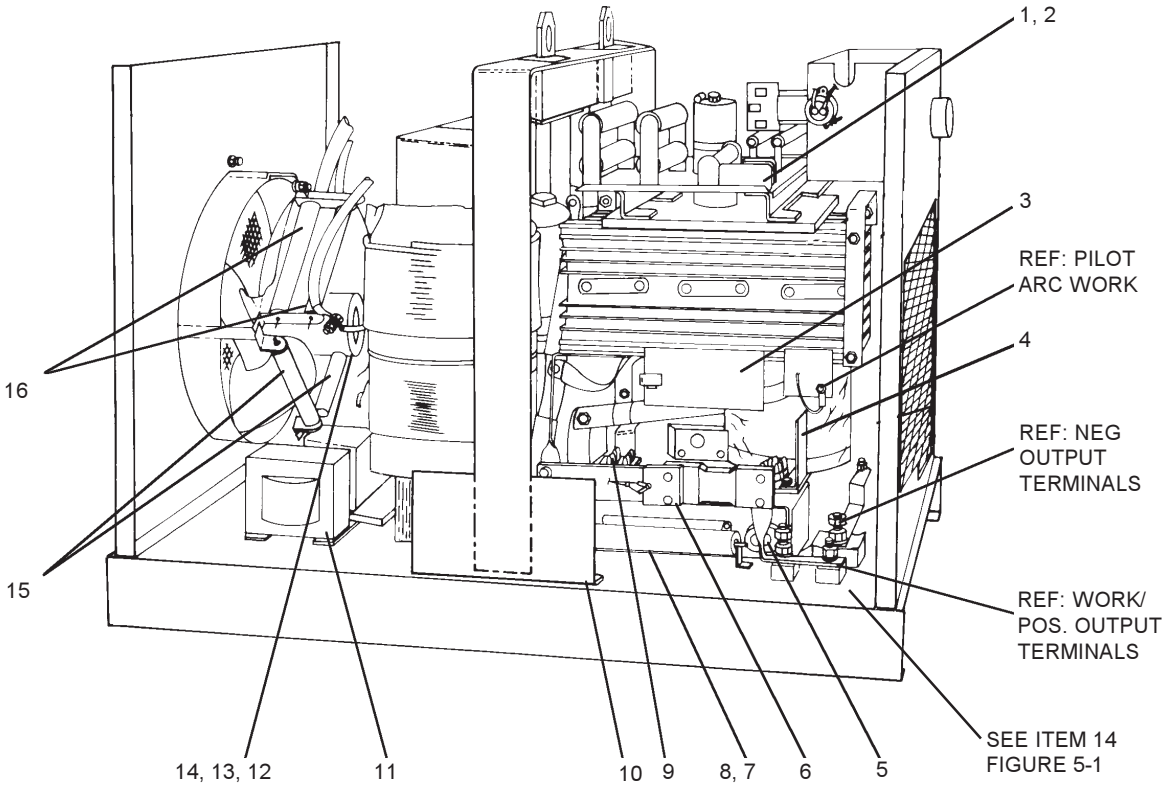


Figure 5-3. ESP-400 Power Source (Left Side View)

Item No.	Qty Req.	Part No.	Description	Circuit Symbol
1	1	2062357	Fuse, 30 A	F6
2	1	951756	Fuse Mount	
3	1	674970	Filter, PC Board Assembly	PCB3
4	1	951223	Shunt, 50 mV, 500 A	SH1
5	1	672772	Capacitor, 10 µF, 370 V ac (same as Item 8, figure 5-4)	C19
6	1	951222	Shunt, 100 mV, 500 A	SH2
7	1	17300020	Resistor, 20 ohm, 300 W, 10%	R15
8	1	17280010	Resistor, 10 ohm, 100 W, 5% (behind R15, Item 5)	R4
9	2	672577	Fuse Link, 500 A	F3,4
10	1	950228	Fuse, 4 A, 500 V (behind plate on chassis base)	F5
11	1	677384	Control Transformer	T2
	1	2062211	Thermostat (P/O Item 11)	
12	1	2062334	Fan Motor	M1
13	1	673676	Fan Blade	
14	1	672330	Fan Shroud	
15	2	17300001	Resistor, 1 ohm, 300 W, 10% (fan shroud)	R5,6
16	2	17300008	Resistor, 8 ohm, 300 W, 10% (fan shroud)	R7,8

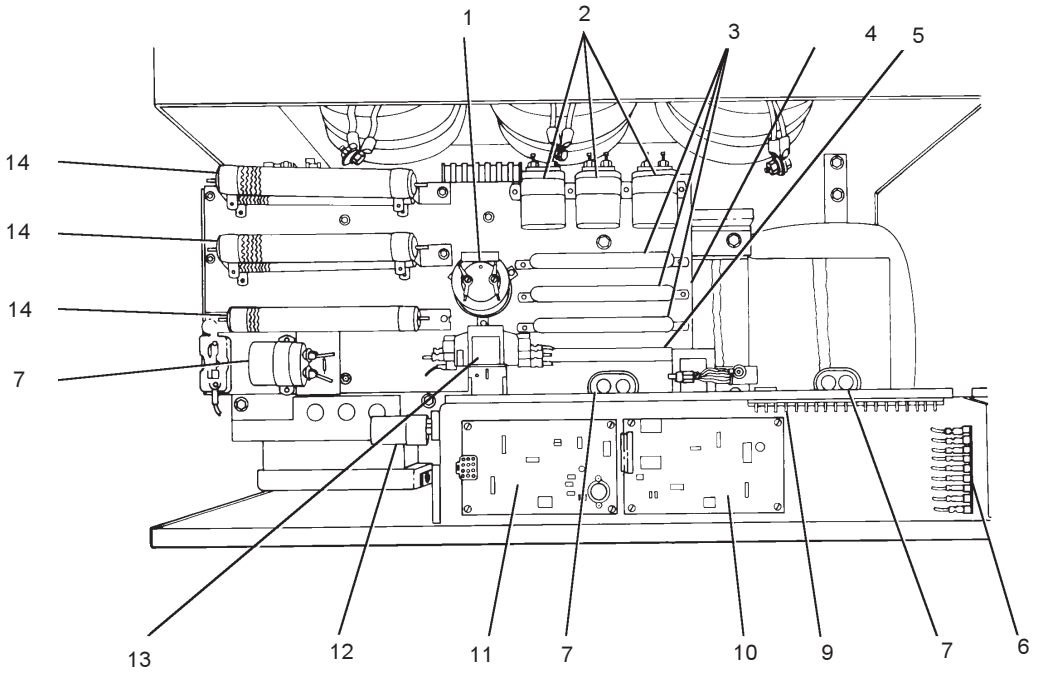


Figure 5-4. ESP-400 Power Source (Top View)

Item No.	Qty Req.	Part No.	Description	Circuit Symbol
1	1	2232378	Capacitor, 1300 µF, 450 V dc	C26
2	3	672772	Capacitor, 10 µF, 370 V ac (same as Item 6, figure 5-2)	C13,14,15
3	3	17280010	Resistor, 10 ohm, 100 W, 5%	R1,2,3
4	-		Main Bridge Assembly. Includes following:	BR
	4	2062304	a. Reverse Silicone Rectifiers	D4,5,6,7
	3	950634	b. Silicone Controlled Rectifiers	SCR4,5,6
	3	950124	c. Bar Stud (for 4c.)	
	3	950177	d. Spring Assembly, 2000 lbs (for 4c.)	
	1	950711	e. Thermal Switch (for 4)	
	2	672225	f. Standoffs (for 4)	
5	1	17280210	Resistor, 1K ohm, 100 W	R27
6	1	635686	Terminal Block, 8-Position	TB4
7	3	672772	Capacitor, 10 µF, 370 V ac (same as Item 3, figure 5-3)	C16,17,25
9	1	635568	Terminal Block, 18-Position, 20 A	TB1
10	1	31492	Constant Current PC Board Assembly	PCB1
11	1	31444	SCR PC Board Assembly	PCB2
12	1	993539	Capacitor, 1500 µF, 50 W V dc	C20
13	1	673458	Contactor, 110 V ac	K2
14	5	17300008	Resistor, 8 ohm, 300 W, 10%	R22,23,24,25, 26

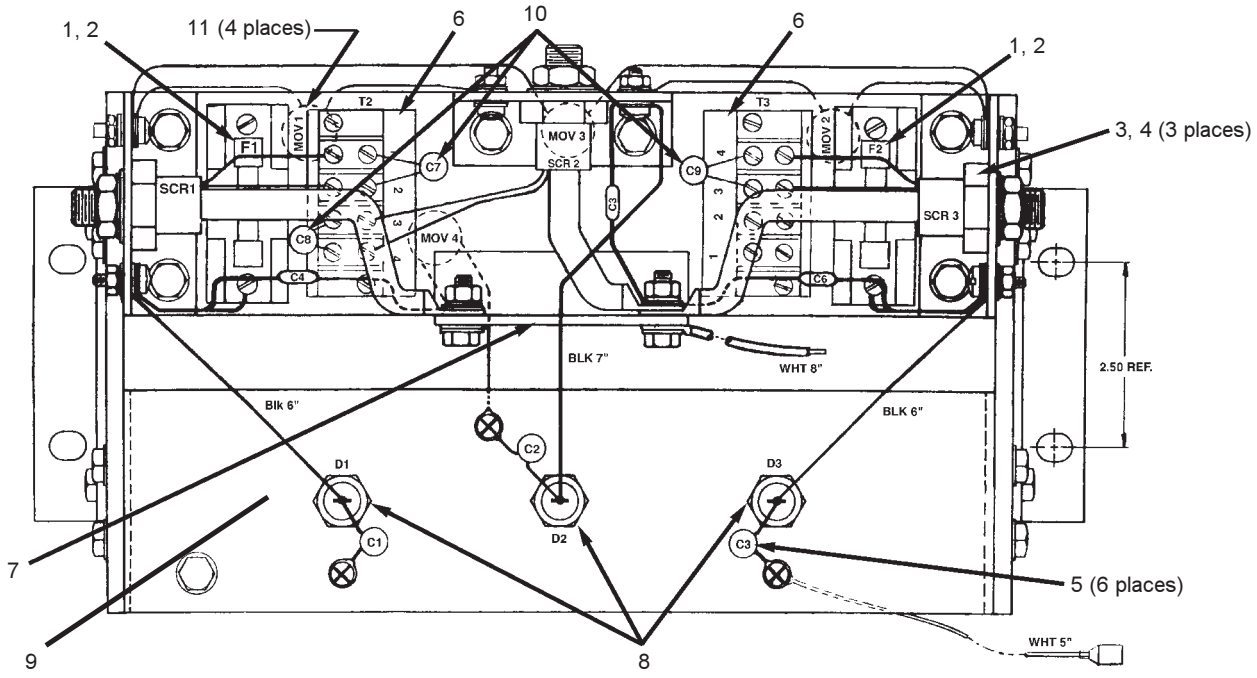


Figure 5-5. ESP-400 Power Source Boost Bridge Rectifier

Item No.	Qty Req.	Part No.	Description	Circuit Symbol
1	2	2062357	Fuse, 30 A	F1,2
2	2	951756	Fuse Mount	
3	3	950066	Silicon Controlled Rectifiers	SCR1-3
4	3	676743	Heat Sinks (for SCR1-3)	
5	6	672348	Capacitors	C1-6
6	2	92W11	Terminal Board	TB2-3
7	1	676770	Positive (+) Heat Sink	
8	3	950527	Silicon Rectifier Diodes	D1-3
9	1	676765	Negative (-) Heat Sink	
10	3	950169	Capacitors	C7-9
11	4	950065	Metal Oxide Varistor	MOV1-4

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